

1     Apparatus and Method for Identifying an Object  
2     having randomly distributed identification elements  
3  
4     The present invention relates to a method and  
5     apparatus for checking that an object is genuine.  
6     The object has a plurality of randomly distributed  
7     identification elements affixed to or embedded in  
8     the object. The object also has a reference point  
9     defining an area of the object in which at least  
10    some of the identification elements are provided.  
11    The invention relates especially, but not  
12    exclusively, to fluorescent identification elements.  
13  
14    At present, to prevent forgery of an object such as  
15    a credit card, a security device, e.g. a security  
16    hologram, is attached to the document. The document  
17    is difficult to forge because it is hard to recreate  
18    the hologram. However, this is quite expensive and  
19    furthermore, identical holograms are used for many  
20    cards, so the hologram cannot distinguish one  
21    particular card from another. Moreover, whilst  
22    security holograms can be attached to high cost

1 items such as credit cards, the weight and cost  
2 makes it impractical to attach these to low-cost  
3 paper documents, such as bank notes.

4

5 It is also known to make paper having embedded UV  
6 fibres, and use this for creating bank notes.  
7 However, this system is only used as a simple yes/no  
8 check on whether the bank note does in fact contain  
9 any UV fibres. If a batch of bank paper having the  
10 embedded UV fibres were stolen, or if forgers were  
11 to create bank notes out of their own paper having  
12 embedded UV fibres, this would not be detectable by  
13 the present systems.

14

15 According to a first aspect of the present invention  
16 there is provided an object having a primary  
17 identifier in the form of a plurality of  
18 identification elements embedded in the object, the  
19 identification elements being visually detectable  
20 when illuminated by infrared or ultraviolet  
21 electromagnetic radiation but being visually  
22 indistinguishable from the rest of the object when  
23 illuminated with visible light; wherein the  
24 identification elements are randomly distributed so  
25 that the positions of the identification elements  
26 are unique to the object; and wherein the object is  
27 provided with a reference point in the form of a  
28 printed symbol defining an area of the object in  
29 which at least some of the identification elements  
30 are provided.

31

1 The identification elements being indistinguishable  
2 from the rest of the object when illuminated by  
3 visible light provides the advantages that the  
4 presence (and location) of the identification  
5 elements is not immediately apparent; therefore the  
6 fact that the object is security-protected is not  
7 obvious. This prevents opportunists from easily  
8 being able to make effective counterfeits.

9  
10 According to a further aspect of the present  
11 invention there is provided an object having a  
12 primary identifier in the form of a plurality of  
13 identification elements affixed to the object, the  
14 identification elements being detectable in  
15 infrared, visible or UV wavelengths when illuminated  
16 by electromagnetic radiation having a wavelength of  
17 less than 0.1m; wherein the identification elements  
18 are randomly distributed so that the positions of  
19 the identification elements are unique to the  
20 object; and wherein the object is provided with a  
21 reference point defining an area of the object in  
22 which at least some of the identification elements  
23 are provided.

24  
25 The identification elements being randomly  
26 distributed provides the object with a unique  
27 identification means, which distinguishes the object  
28 from any other object. The reference point enables  
29 consistent and accurate identification of the same  
30 area of the object, even when examined at different  
31 times by different detectors.

32

1 The reference point can define a particular area of  
2 the object to be examined, instead of the whole area  
3 of the object requiring examination. This can save  
4 a significant amount of time. In some embodiments,  
5 the reference point does not indicate to a potential  
6 counterfeiter the area of the object that will be  
7 examined. For example, if the reference point is a  
8 single printed symbol, the area of the object could  
9 be above, below or to either side of the reference  
10 point, by a small or a large distance. This  
11 prevents counterfeiters from knowing which parts of  
12 the object contain the identification elements which  
13 will be examined.

14  
15 The positions of the identification elements in an  
16 area defined by the reference point can be recorded  
17 to provide a unique "fingerprint" record which can  
18 be checked later to confirm the object is genuine.

19  
20 Typically, the identification elements comprise  
21 fibres. Optionally, the fibres are selected from  
22 the group consisting of viscose, wool, cellulose,  
23 synthetic fibres, paper and water-resistant paper;  
24 preferably, the fibres are viscose fibres.

25  
26 Alternatively, the identification elements are in  
27 the form of solid particulates. Optionally, the  
28 identification elements are selected from the group  
29 consisting of mica, silica and synthetic  
30 particulates.

31

1 Typically, the identification elements are  
2 fluorescent so that they emit visible light in  
3 response to ultraviolet light. Typically, the  
4 identification elements are provided with a  
5 fluorescent coating (e.g. by being dyed with a  
6 fluorescent dye). Alternatively, the identification  
7 elements are visible when illuminated by light of  
8 optical or infrared wavelengths (by reflection or  
9 absorption and re-emission).

10

11 Preferably, the identification elements form an  
12 integral part of the object (e.g. by being embedded  
13 in the object). Alternatively, the identification  
14 elements can be affixed to the surface of the  
15 object.

16

17 Preferably, the reference point is in the form of a  
18 printed symbol. Preferably, the reference point  
19 does not have rotational symmetry, so that the  
20 orientation of the object can be determined from the  
21 orientation of the reference point. Preferably, the  
22 reference point is in a T-shape.

23

24 Optionally, the object is a liquid. Optionally, the  
25 object is ink, and the identification elements  
26 comprise a suspension in the ink.

27

28 Optionally, the object comprises paper.  
29 Alternatively, the object comprises plastic or  
30 metal.

31

1 Preferably, the genuine object is provided with a  
2 secondary identifier; most preferably, the secondary  
3 identifier is unique to the genuine object.  
4 Optionally, the secondary identifier is printed on  
5 the object. Optionally, the secondary identifier  
6 comprises a number. Alternatively, the secondary  
7 identifier comprises a one-dimensional barcode or a  
8 two-dimensional barcode.

9  
10 Embodiments which include a unique secondary  
11 identifier have the advantage that the object need  
12 only be compared with a single object bearing the  
13 same secondary identifier. This can provide a  
14 significant advantage in terms of processing speed.

15  
16 According to a second aspect of the present  
17 invention, there is provided a method of verifying  
18 that an object is genuine, including the steps of:  
19 creating a genuine object having a primary  
20 identifier in the form of a plurality of  
21 identification elements embedded in the object, the  
22 identification elements being visually detectable  
23 when illuminated by infrared or ultraviolet  
24 electromagnetic radiation but being visually  
25 indistinguishable from the rest of the object when  
26 illuminated with visible light; wherein the  
27 identification elements are randomly distributed so  
28 that the positions of the identification elements  
29 are unique to the genuine object; and wherein the  
30 genuine object is provided with a reference point in  
31 the form of a printed symbol defining an area of the

1 object in which at least some of the identification  
2 elements are provided;  
3 recording information relating to the positions  
4 of the identification elements relative to the  
5 reference point in the genuine object; and  
6 comparing measured information relating to the  
7 positions of identification elements in an object to  
8 be verified with the recorded information for the  
9 genuine object.

10

11 According to a further aspect of the present  
12 invention there is provided a method of verifying  
13 that an object is genuine, including the steps of:  
14 creating a genuine object having a primary  
15 identifier in the form of a plurality of  
16 identification elements affixed to the object, the  
17 identification elements being detectable in  
18 infrared, visible or UV wavelengths when illuminated  
19 by electromagnetic radiation having a wavelength of  
20 less than 0.1m; wherein the identification elements  
21 are randomly distributed so that the positions of  
22 the identification elements are unique to the  
23 genuine object; and wherein the genuine object is  
24 provided with a reference point defining an area of  
25 the object in which at least some of the  
26 identification elements are provided;  
27 recording information relating to the positions  
28 of the identification elements relative to the  
29 reference point in the genuine object; and  
30 comparing measured information relating to the  
31 positions of identification elements in an object to

1 be verified with the recorded information for the  
2 genuine object.

3

4 Preferably, the information relating to the  
5 positions of the identification elements in the  
6 genuine object is recorded in a database.

7

8 Preferably, the positions of the identification  
9 elements are converted into a numerical code for  
10 storage in the database.

11

12 Preferably, the positions of the identification  
13 elements are converted into an alphanumerical code  
14 for storage in the database.

15

16 Preferably, the numerical/alphanumerical code  
17 created is unique to that object. This is typically  
18 due to the identification elements being positioned  
19 randomly in the object. This unique numerical/  
20 alphanumerical code cannot be reverse engineered to  
21 determine the location of the identification  
22 elements in the object. This makes the object  
23 considerably more difficult, if not impossible, to  
24 counterfeit.

25

26 Typically, only information relating to  
27 identification elements within a specified area  
28 relative to the reference point is recorded.

29

30 Typically, the method includes the step of measuring  
31 the positions of identification elements in the  
32 object to be verified. Preferably, the positions of



1 identification elements in the object to be verified  
2 are measured relative to a reference point in the  
3 object to be verified.

4  
5 Typically, the information relating to the positions  
6 of the identification elements in the genuine object  
7 is converted into a numerical (or alphanumerical)  
8 code and recorded in this form. Typically, the  
9 measured information relating to the positions of  
10 identification elements in the object to be verified  
11 is also in the form of a numerical (or  
12 alphanumerical) code, and the step of comparing the  
13 information comprises comparing these codes.

14  
15 Preferably, corresponding numbers in each numerical  
16 (or alphanumerical) code are compared, to within a  
17 specified tolerance level. Different tolerance  
18 levels can be provided to correspond to different  
19 levels of security.

20  
21 Typically, the genuine object is provided with a  
22 secondary identifier, and the method includes the  
23 step of detecting and recording information relating  
24 to the secondary identifier. Preferably, the  
25 secondary identifier is unique to the object.  
26 Preferably, a plurality of genuine objects are  
27 created and recorded. Optionally, information  
28 relating to the object to be verified is only  
29 compared to recorded information relating to genuine  
30 objects having the same secondary identifier.

31

1 Typically, the identification elements are  
2 fluorescent, and the method includes the step of  
3 illuminating the identification elements with  
4 ultraviolet light, and detecting the emitted visible  
5 light with a camera. Typically, the camera image is  
6 then analysed and converted into numerical data.

7  
8 Optionally, the genuine object comprises paper, and  
9 the method includes the step of adding the  
10 identification elements to the paper during the  
11 paper-making process, so that the identification  
12 elements form an integral component of the finished  
13 paper.

14  
15 According to a third aspect of the present invention  
16 there is provided a detector for verifying that an  
17 object according to the present invention is  
18 genuine, comprising a source of infrared or  
19 electromagnetic radiation; a camera; image analysis  
20 equipment for converting the camera image into an  
21 alphanumeric code; a database into which the  
22 alphanumeric code can be recorded and from which  
23 alphanumeric codes relating to other recorded  
24 camera images can be retrieved; and processing  
25 equipment adapted to compare the alphanumeric code  
26 relating to the object being verified with the other  
27 alphanumeric codes already stored in the database  
28 relating to recorded camera images.

29  
30 According to a further aspect of the present  
31 invention there is provided a detector for verifying  
32 that an object according to the present invention is

1 genuine, comprising a source of electromagnetic  
2 radiation having a wavelength of less than 0.1m; a  
3 camera capable of detecting wavelengths between  
4 infrared and ultraviolet; image analysis equipment  
5 for converting the camera image into a numerical  
6 code; a database into which the numerical code can  
7 be recorded and from which numerical codes relating  
8 to other recorded camera images can be retrieved;  
9 and processing equipment adapted to compare the  
10 numerical code relating to the object being verified  
11 with the other numerical codes already stored in the  
12 database relating to recorded camera images.

13

14 Typically, the processing equipment uses a  
15 processing algorithm.

16

17 Preferably, the detector is adapted to be hand-held.

18

19 Optionally, the detector includes a conveyor for  
20 conveying the object past the source of  
21 electromagnetic radiation and the camera.

22

23 Preferably, the detector is adapted to detect the  
24 location of a reference point on the object, and to  
25 direct the camera to this part of the object.

26

27 Typically, the source of electromagnetic radiation  
28 comprises a source of ultraviolet light. Typically,  
29 the camera is adapted to detect visible light.

30

31 Typically, the image analysis equipment is adapted  
32 to divide the camera image into a plurality of sub-

1 regions and to count the number of pixels  
2 illuminated in each sub-region to produce a  
3 numerical (or alphanumerical) code corresponding to  
4 the camera image.

5

6 Typically, the processing equipment is adapted to  
7 compare the numerical (or alphanumerical) codes to  
8 within a specified tolerance level.

9

10 Optionally, the detector is adapted to compare the  
11 numerical (or alphanumerical) code relating to the  
12 object to be verified with all of the numerical (or  
13 alphanumerical) codes in the database.

14

15 Alternatively, the detector is adapted to recognise  
16 and record information relating to a secondary  
17 identifier, and the processing equipment is adapted  
18 to compare the numerical (or alphanumerical) code  
19 relating to the object to be verified only to  
20 numerical (or alphanumerical) codes relating to  
21 recorded objects that have the same secondary  
22 identifier.

23

24 An embodiment of the invention will now be  
25 described, by way of example only, and with  
26 reference to the following drawings, in which:-

27

28 Fig 1 shows a bank note according to the present  
29 invention, having fibres visible in UV light  
30 embedded within it;

31

1 Fig 2 shows an object according to the invention in  
2 the form of a cheque;

3

4 Fig 3 shows an enlarged portion of a part of the  
5 cheque as seen by a camera able to detect UV  
6 radiation; and

7

8 Fig 4 shows the camera image of Fig 3 divided into  
9 squares as a means of recording the location of the  
10 fibres within the image.

11

12 In a first embodiment of the invention, an object in  
13 the form of a bank note 10 as shown in Fig 1. The  
14 bank note has identification elements in the form of  
15 viscose fibres 20 (brand name: Rayon) embedded  
16 within it. The viscose fibres 20 have been dyed  
17 with a fluorescent dye so that they emit visible  
18 light in response to incoming ultraviolet radiation.  
19 (the viscose fibres 20 will hereinafter be called UV  
20 fibres 20). The fluorescent dye makes the UV fibres  
21 20 visible against the background cellulose fibre of  
22 the paper.

23

24 The UV fibres are arranged in a random orientation  
25 in the bank note 10.

26

27 It should be noted that the UV fibres 20 are not  
28 necessarily visible to the naked eye; however, they  
29 have been shown in Fig 1 by way of example only.  
30 The UV fibres 20 in this drawing are not to scale.

31

1 Preferred UV fibre dimensions are approximately 4 to  
2 8 millimetres in length (most preferably 6  
3 millimetres) and 20 to 40 microns in diameter (most  
4 preferably 30 microns); however the UV fibres may  
5 have a wide range of lengths and diameters.

6  
7 All the usual printed information and detail (not  
8 shown) is printed on the bank note 10. This  
9 information includes a serial number 50, which  
10 serves as a unique primary identifier, to  
11 distinguish this particular bank note 10 from other  
12 bank notes.

13  
14 Since the paper from which the bank note 10 is made  
15 has UV fibres embedded in random positions  
16 throughout the paper, the positions of the UV fibres  
17 are unique to the bank note 10. The positions of  
18 the UV fibres can be observed (e.g. by a detector  
19 which will be subsequently described) and stored in  
20 a database, together with the serial number 50 of  
21 the bank note 10; this would typically happen  
22 shortly after the bank note 10 has been created,  
23 whilst the newly created bank note 10 is still in  
24 the control of the bank.

25  
26 After the bank note 10 has been put into  
27 circulation, to check whether a bank note bearing  
28 serial number 50 is in fact the genuine bank note  
29 10, the serial number 50 is read and the positions  
30 of the UV fibres 20 are observed. If the positions  
31 of the UV fibres 20 match the positions recorded in

1 the database for bank note 10, the bank note is  
2 deemed genuine.

3  
4 In some embodiments, it is not necessary to record  
5 the position of every UV fibre 20 in the bank note;  
6 rather it is more efficient just to record and  
7 compare the UV fibres in a particular part of the  
8 bank note, for example area 40 of bank note 10. For  
9 this purpose a reference point in the form of a  
10 marker device comprising a printed T-shape 30 is  
11 provided. T-shape 30 can be used as a reference  
12 element to direct a camera to observe the UV fibres  
13 within a particular boundary (e.g. area 40) relative  
14 to the printed T-shape 30.

15  
16 Alternatively, a camera may observe the entire area  
17 of the bank note, but only information relating to  
18 the UV fibres 20 within a particular boundary may be  
19 recorded.

20  
21 A method of creating paper with embedded UV fibres  
22 will now be described.

23  
24 Firstly, the UV fibres are created by making viscose  
25 fibres of the above dimensions and then dying them  
26 with a dye that is visible in ultraviolet radiation.  
27 The dye is a fluorescent dye, so that the dyed  
28 fibres can absorb ultraviolet radiation and emit  
29 visible light in response.

30  
31 As is generally known in the paper making industry,  
32 paper is made by dispersing cellulose fibres in

1 water in the approximate ratio of one part fibre to  
2 100 parts of water. This dispersion is pumped on to  
3 a continuously moving porous belt. The water drains  
4 through the belt leaving the fibre behind on the  
5 surface to form a mat. When the concentration of  
6 the fibre has risen to approximately 20%, the mat is  
7 strong enough to support itself. At this point, the  
8 mat is lifted off the belt, pressed through rollers  
9 to remove more water and then dried against hot  
10 cylinders.

11

12 UV fibres are added to the dispersion just before  
13 the dispersion is pumped onto the belt. The  
14 addition rate depends on the desired density of UV  
15 fibres in the finished paper. A typical addition  
16 rate is 2kg of fibres per 1000kg of finished paper.  
17 This method of adding the UV fibres to the  
18 dispersion has the advantage that the UV fibres will  
19 form an integral part of the paper structure.  
20 Furthermore, this method ensures that the UV fibres  
21 are distributed in a random manner throughout the  
22 paper. This helps ensure that the pattern of UV  
23 fibres in each piece of paper made by this  
24 technique.

25

26 It has been discovered that if the UV fibres are too  
27 short and thin, they could drain through the fabric  
28 of the paper whilst the paper is being formed. If  
29 the UV fibres are too long and wide, they could  
30 cause knots or clumps, which could lead to the  
31 fibres being rejected by the cleaning system.



1     Fibres of the dimensions given above have been found  
2     not to cause either of these problems.

3  
4     A detector (not shown) suitable for use with such  
5     objects will now be described. The detector is  
6     adapted both to "lock in" (i.e. record in a  
7     database) details concerning an object, and also to  
8     "unlock" (i.e. to read) the document to verify that  
9     the object is genuine. The detector includes a UV  
10    source and a camera. The camera is adapted to  
11    detect the light produced by the UV fibres in an  
12    object on illumination of these UV fibres by the UV  
13    source. The detector also includes image analysis  
14    equipment for evaluating the pictures taken by the  
15    camera. The detector includes a device for  
16    detecting a reference point (e.g. T-shape 30), which  
17    indicates which part of the object to photograph,  
18    and/or which part of the object to analyse. The  
19    detector also includes a scanner and associated  
20    recognition technology, which is adapted to read a  
21    secondary identifier in the form of a number (e.g. a  
22    serial number) printed on the object. The detector  
23    also includes a conveying means in the form of a  
24    conveyor belt for conveying an object past a  
25    stationary UV source and a stationary camera.

26  
27    In alternative embodiments, the detector is hand-  
28    held and it does not necessarily have a conveying  
29    means.

30  
31    The detector is coupled to a PC, which serves as an  
32    interface between an operator and the detector. The

1 PC has access to a database in which the serial  
2 number and information relating to the analysed  
3 images can be stored. This database may be stored  
4 in the PC itself, or in another PC (e.g. a central  
5 computer which stores data which can be accessed by  
6 many detectors via the internet). Having a database  
7 which is external to the detector is advantageous in  
8 the case that the place to verify the object is  
9 different from the place of creation of the object.  
10 For example, bank notes will be created by a bank,  
11 but verification of the notes will take place in  
12 many different shops. It is useful as each shop has  
13 a detector which can refer to a central database  
14 containing information on all issued bank notes.  
15  
16 A use of the detector to lock and unlock a cheque 60  
17 having embedded UV fibres will now be described;  
18 cheque 60 is shown in Fig 2 and has a serial number  
19 70. Cheque 60 is also provided with a reference  
20 point in the form of a marker 80, which defines a  
21 region 90 of the cheque to be photographed by the  
22 camera in the detector. The marker 80 is shown  
23 symbolically as a square; however, a preferred form  
24 of marker 80 is a T-shape. T-shape markers have the  
25 advantage that it is easy to tell which way up the  
26 T-shape is, thus, the T-shape helps to ensure that  
27 the correct area 80 is photographed by the camera,  
28 and/or that the correct area 80 is analysed. If,  
29 for example, the cheque is inserted the wrong way  
30 round, this would be noticed from the T-shape and it  
31 would be possible for the image analysis equipment

1 to make corresponding adjustments, so that the  
2 correct area 80 is photographed and/or analysed.

3  
4 Cheque 60 is also provided with a printed symbol 65  
5 (magnified view also shown), which indicates that  
6 the cheque 60 has been "security locked", to act as  
7 a deterrent to potential forgers.

8  
9 In use, to lock the cheque 60, one would select an  
10 option in the PC, which would instruct the detector  
11 to expect an object and to tell the detector to  
12 "lock" this object into the database. The cheque 60  
13 is then put onto the conveying means, which conveys  
14 the cheque 60 past the UV source and the camera.  
15 The UV source illuminates the cheque 60 with UV  
16 radiation. The marker 80 is detected by the  
17 detector, which sends a signal to the camera to  
18 photograph a region 90 of the cheque 60. The  
19 incident UV radiation causes the fluorescent UV  
20 fibres to emit visible light, which is detected by  
21 the camera observing region 90. Also whilst being  
22 conveyed, the detector reads the serial number 70  
23 with the scanner and stores this number.

24  
25 The use of the marker 80 ensures that the same area  
26 of cheque 60 is photographed each time, which  
27 provides consistent, reproducible measurements, even  
28 when measured by different detectors at different  
29 times.

30  
31 The camera image is then analysed by the image  
32 analysis equipment. Alternatively, the entire area

1 of the cheque 60 is photographed, but only the  
2 region 90 is analysed. Fig 3 shows a magnified  
3 image of region 90, which contains two UV fibres 95.  
4 Fig 4 shows how the region 90 can be split up in  
5 smaller boxes of equal area, the boxes being  
6 numbered 101 to 109.

7  
8 Each square contains 100 x 100 pixels, which gives a  
9 resolution of 0-99999. Using binary thresholding, a  
10 value is given to each box 101 to 109 based on the  
11 pixel count. A tolerance is added, which is plus or  
12 minus a certain amount, where this amount  
13 corresponds to a selected level of security.

14  
15 The number of pixels in each box is then counted;  
16 the results are shown in Table 1.

17  
18 Table 1

Box Number	Number of Pixels	Tolerance
101	00021	± X1
102	01124	± X1
103	00000	± X1
104	00004	± X1
105	00237	± X1
106	00128	± X1
107	00000	± X1
108	00000	± X1
109	00265	± X1

19

20 Where

21 X1 = 10% = low security

22 X2 = 5% = medium security

1 X3 = 2% = high security

2

3 The above results are then stored in the database  
4 together with the serial number 70. This completes  
5 the locking process. This procedure is preferably  
6 done soon after creation of the cheque 60, before it  
7 leaves the control of the bank.

8

9 To unlock a cheque having a serial number 70, an  
10 "unlock" command is given to the PC. The cheque is  
11 put onto the conveyor means, and conveyed past the  
12 UV source and the camera as explained above with  
13 respect to locking the cheque. The incident UV  
14 radiation causes the UV fibres 95 to fluoresce,  
15 emitting visible light, which is photographed by the  
16 camera. The camera image is subdivided into boxes  
17 by the image analysis equipment, and the number of  
18 pixels detecting light in each box is counted, as  
19 before. The serial number 70 is also read by the  
20 scanner in the detector, and the detector then  
21 compares the number of illuminated pixels of the  
22 camera image from each box, with the corresponding  
23 information recorded in the database for the cheque  
24 60 having serial number 70.

25

26 If the two results are the same to within the  
27 selected tolerance level (in the above example, plus  
28 or minus 10%), this indicates that the cheque being  
29 unlocked is the genuine cheque 60, and the PC  
30 returns a "Verified" message to the user. If the  
31 numbers of pixels are more different than this, the  
32 cheque being unlocked cannot be the cheque 60 and

1 must be a forgery. In this case, the PC returns a  
2 "Sorry, this cheque is not verified" message to the  
3 user.

4  
5 Modifications can be incorporated without departing  
6 from the scope of the present invention. For  
7 example, the identification elements are not  
8 necessarily fibres. For example, the identification  
9 elements can comprise particles of mica, silica,  
10 synthetic material, which have optionally been  
11 coated with an ultraviolet dye, or planchetta  
12 (water-resistant pieces of paper printed with UV or  
13 IR ink). If fibres are used, these are not  
14 necessarily viscose fibres; alternatively wool,  
15 cellulose, or paper can also be used. The fibres  
16 may be formed from synthetic or naturally occurring  
17 materials. The invention is not limited to any of  
18 these examples of identification elements. The  
19 identification elements can be anything which can be  
20 distributed randomly on or throughout the object.

21  
22 The identification elements are not necessarily  
23 responsive to UV radiation; they could alternatively  
24 be responsive to gamma ray, X-ray, visible light,  
25 infrared or microwave radiation.

26  
27 In the case of identification elements responsive to  
28 visible light, the fibres could simply be of a  
29 different colour to the rest of the paper, and the  
30 location of the fibres can be observed by a camera,  
31 just due to reflection of light, without any  
32 fluorescent effect at all.

1  
2 In alternative embodiments, the fibres could be  
3 uniform in length.  
4

5 In some embodiments, the UV fibres can be added at  
6 other points in the paper-making process, other than  
7 to the dispersion prior to this being pumped on to  
8 the moving belt. For example, the UV fibres could  
9 be added at a dispersing unit (e.g. a broke pulper  
10 or a virgin fibre pulper) or at a size press.  
11

12 The Fig 1 embodiment has a secondary identifier in  
13 the form of a printed serial number, which is  
14 visible to the eye. However, other embodiments do  
15 not require a secondary identifier. For example, in  
16 the case of bank notes, information relating to the  
17 arrangement of identification elements relating to  
18 each created genuine bank note can be recorded in a  
19 database. When the detector comes to unlock a bank  
20 note to verify that it is genuine, the arrangement  
21 of identification elements in the bank note being  
22 unlocked can be compared to each recorded  
23 arrangement. If the bank note had been printed on  
24 stolen paper having embedded identification  
25 elements, there would not be any bank note locked in  
26 the database having that precise pattern of  
27 identification elements, and so the bank note would  
28 be deemed a forgery.  
29

30 If a secondary identifier is provided, this could be  
31 in the form of features of shape, colour, texture  
32 (e.g. braille); the secondary identifier can be

1 preferably serves as a unique identifier for a  
2 particular object. The secondary identifier could  
3 also comprise a second area of paper having embedded  
4 UV fibres. The secondary identifier could be a 1-  
5 dimensional or 2-dimensional bar code. In certain  
6 embodiments, primary identifier (e.g. the UV fibres)  
7 can be located directly underneath a secondary  
8 identifier in the form of a barcode or other  
9 printing.

10

11 In some embodiments, the detector could include or  
12 have access to pre-existing equipment, such as a  
13 standard barcode reader or serial number reader.

14

15 Embodiments which include a secondary identifier  
16 have the advantage that an object bearing the  
17 secondary identifier need only be compared to the  
18 single object bearing that same secondary identifier  
19 recorded in the database. In embodiments not having  
20 a secondary identifier, the object would have to be  
21 compared with all of the objects stored in the  
22 database. For embodiments such as bank notes, using  
23 a secondary identifier would provide a significant  
24 advantage in terms of speed.

25

26 The identification elements are not necessarily  
27 embedded in the paper; for example, the  
28 identification elements could be contained in an ink  
29 which is printed on to the paper.

30

31 Although the specific embodiments described above,  
32 (a cheque and a bank note) are both types of paper



1 document, the invention is not limited to the use of  
2 paper or documents as such. For example, the object  
3 could be made of plastic, for example a plastic  
4 film. Furthermore, the object could be a CD having  
5 identification elements randomly distributed in the  
6 substrate from which the CD is made.

7  
8 Other kinds of documents which could incorporate  
9 this system include passports and drivers licences.  
10 The invention provides security to all of kinds of  
11 objects at minimal expense, as the unique identifier  
12 can be incorporated into the fabric of the document  
13 itself.

14  
15 The identification elements are not necessarily  
16 fibres.

17  
18 In some embodiments, a first device could be used to  
19 lock (encode) an object, and a second, different  
20 device could be used to unlock (verify) an object.

21  
22 In alternative embodiments, the detector may not  
23 have a conveying means, and the camera may be  
24 optionally moveable/directionable to scan across an  
25 area of a stationary object. Such embodiments are  
26 useful when the object to be scanned is a document  
27 affixed to a large object, or a large object itself,  
28 which could not be put through a conveying means.

29  
30 In other embodiments, the detector could split up  
31 the camera image into more or fewer squares to alter  
32 the tolerance levels of the count.

1

2 The detector can be used in co-operation with other  
3 kinds of computer, such as a personal digital  
4 assistant or laptop.

5

6 More than one reference point could be used to  
7 indicate the portion of the object which should be  
8 photographed. "Photograph" is intended to include  
9 an image made from any type of electromagnetic  
10 radiation. The reference point is not necessarily a  
11 printed symbol; it could alternatively comprise a  
12 corner of the object, a perforated line or a  
13 recessed or projecting region of the object. The  
14 reference point is optionally concealed from the  
15 naked eye; for example, the reference point could  
16 comprise a fluorescent element embedded in the  
17 object.

18

19 The image analysis does not have to work by counting  
20 pixels; any means of comparing a received image from  
21 a document to be unlocked with the image stored for  
22 that serial number could be used.

23

24 The UV fibres could be adapted to reflect  
25 ultraviolet radiation, and/or absorb and re-emit the  
26 ultraviolet radiation. The UV fibres can be formed  
27 from a material which is naturally fluorescent;  
28 therefore the UV fibres are not necessarily dyed.

29

30 In alternative embodiments, the database could be a  
31 component of the detector, rather than an external

1 database associated with a computer or other  
2 processing device.

3

4 In some embodiments, different devices could be  
5 provided for the two tasks of locking and unlocking.

6 For example, in the case of bank notes, a locking  
7 device could be provided at the bank where the notes  
8 are created, and devices adapted to unlock only  
9 could be provided in shops.